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Analysis of abundance of microplastic in fish caught in Percut Waters

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ABSTRACT

Plastic waste that is not managed properly will damage the environment by polluting the ecosystem. Plastic in waters can turn into micro-sized plastic waste. Plastics whose size is less than 5 mm are called microplastics. The emergence of microplastic pollutants is caused by increasing population activity in Percut Waters. Percut waters are waters located in the coastal area of North Sumatra where there are many anthropogenic activities that cause the emergence of microplastics. Microplastics can have a negative impact on exposed marine biota. Nowadays microplastics are not only found in the environment, but can also accumulate in the bodies of organisms, for example. This research aims to determine the abundance of microplastics in fish found in Percut waters. The research was carried out in October – November 2022 in Percut Waters. Fish samples were caught using nets and the samples were separated from their digestive tract and diluted with the addition of NaCl and H_2O_2 lauric. The average abundance of microplastics in fish samples ranged from 24–294 particles. The fish species where the most microplastics were found was mullet fish with 294 particles. The most common types of microplastics found in total are fiber microplastics.

Introduction

The high level of human activity has caused various impacts, one of which is landfill, especially plastic waste. Plastic waste that is not managed properly will damage the environment by polluting the ecosystem. Plastics that are not managed properly will become microplastics. Indonesia is the second country after China, with a plastic waste disposal rate of 10.1% (Jambeck et al., 2015). Plastics that are less than 5 mm in size are called microplastics (Costello and Ebert, 2020; Hidalgo-Ruz et al., 2012; Akbar *et al.*, 2023). Based on their shape and nature, microplastics are divided into 2 types, namely primary microplastics and secondary microplastics. Primary microplastics come from microbeads, capsules, fibers, and pellets. Meanwhile, secondary microplastics come from the results of plastic waste that is carried into the ocean, broken down into small plastics.

Microplastics are toxic from various chemicals found in seawater, rivers and the surrounding environment, which can be transported directly or indirectly through the food chain and broken down in the fish's body (Hollman et al., 2013). Microplastics can occur in the respiratory and digestive tracts of fish that have habitats in river water and seawater (Cole *et al.*, 2011). Fish can eat microplastics in the waters because microplastics are considered similar to one type of food. Due to their very small size, microplastics can have a significant impact on living things, including humans. Many studies have been conducted to determine the presence of microplastics in fish, research by Febriani *et al.* (2020) showed that microplastics have spread in the waters up to the body of the fish, in the waters of Bengkalis Island, Bengkalis Regency, Riau Province, Coral Fish in the Three Small and Outermost Islands of Papua, Indonesia (Yona et al., 2020), Lemuru Protolan Fish *(Sardinella Lemuru*) in Bali Strait (Yudhantari et al., 2019). Fish is one of the foods most often consumed by humans, because fish is a food that has an economical price and is rich in protein. The entry of microplastics into the fish's body

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can cause chemical-physical damage to the fish's body such as damage to internal organs and blockage of the digestive tract (Yudhantari et al., 2019).

Percut Waters, Percut District, Deli Serdang Regency, is located on the East Coast of North Sumatra. Coastal and coastal areas with a coastline length of 65 km include 4 sub-districts, namely: Percut Sei Tuan District, Pantai Labu District, Hamparan Perak District and Labuhan Deli District. Percut waters are surrounded by residential areas located in estuary areas and floating restaurants built in areas around the sea can cause pollution with waste produced by residents or the restaurants themselves. Percut waters are widely used for many things for the surrounding community, including a source of clean water, irrigation for agriculture, fish ponds, and even a place to dispose of domestic and industrial waste (Machairiyah et al., 2020) that produces plastic waste that has the potential to be microplastic. In the Percut Waters area, there is no adequate waste management or landfill, resulting in piles of rubbish everywhere. The aim of this research was to determine the abundance of microplastics in fish samples and what types of microplastics were most dominantly found.

Materials and Methods

Location and time of research

The research was conducted from October to November 2022 at Percut waters, North Sumatra Province located at coordinates 3°42'51"N 98°46'49"E 3°42'51"N 98°46'49"E. Identification of biota and microplastics was carried out at the Biosystems Engineering Laboratory and Microbiology Laboratory, Faculty of Agriculture, Universitas Sumatera Utara. The location map can be seen in Figure 1.

Data Analysis

Station determination technique in sampling

Determination of stations for sampling is based on environmental baseline by using the "Purposive Sampling" method and following PERDA regulation no. 4 of 2019 concerning Zoning Plans for the Small Islands of North Sumatra. In determining the 3 (three) observation stations, the three stations are considered to represent all water locations based on their characteristics and PERDA No. 4 Year 2019 which is different in the research location. The 3 station locations are station 1 (Ecotourism Zone), Station 2 (Mangrove Zone), Station 3 (Capture Fisheries Zone).

Sample collection method

Fish sampling. The method used in this research is field observation. Fish are caught by using fishing nets. The types of fish used as samples are 3 dominant fish species and each type is limited to 5 fish and the fish caught are fish that are often consumed.

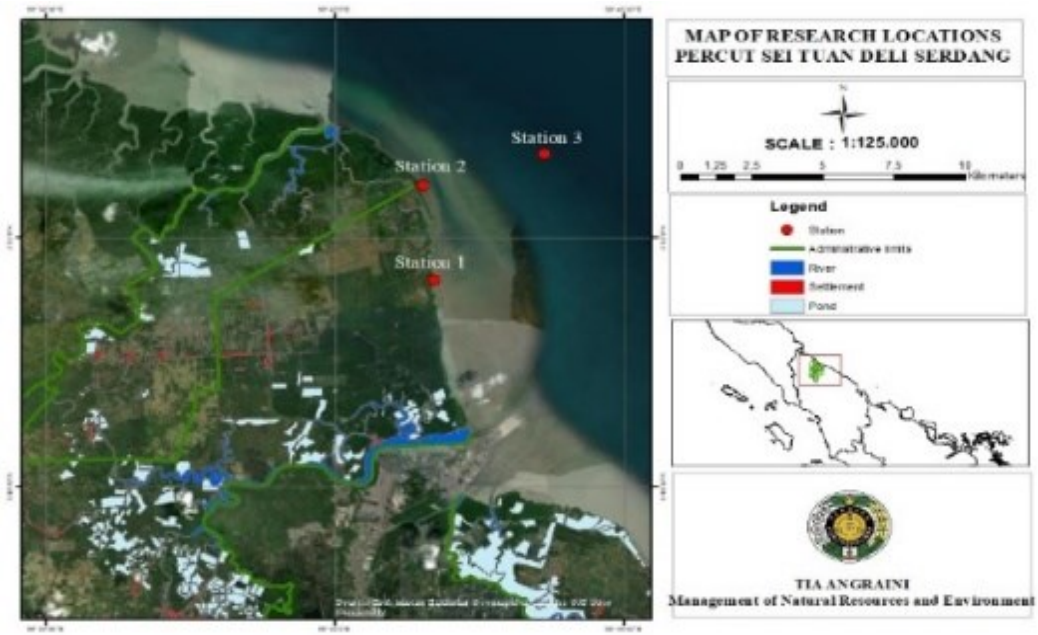

Figure 1. Map of research location.

Laboratory analysis

Digestive contents in the form of stomach and intestines were taken from each sample and placed in 70% alcohol solution for further analysis (Fu et al., 2020; Jantz et al. 2013). Dilution of the contents of the intestine and stomach (digestive tract) of fish

was carried out with 30% H_20_2 solution. Microplastic particles that are difficult to see by the eye were identified using a monocular microscope (magnification 10x10) (Boerger et al., 2010).

Microplastics abundance analysis

Analysis of the abundance of microplastics was calculated using the formula (Boerger et al., 2010):

$$K(\text{unit}) = \frac{Number\ of\ microplastic\ particles}{Number\ of\ fish}$$

Results

Microplastics in Fish

The total fish samples collected from the three stations were 90 specimens consisting of 11 species. The results of the abundance of microplastics obtained in each fish species were very diverse. The threat of microplastics being ingested by biota because of their small size makes microplastics easily ingested by biota. The number of microplastics found in the digestive tract of fish ranges from 45 – 294 particles/individual. In this study, 11 species were found and the scientific names of fish and the distribution of species based on the time of collection are presented in Table 1.

Types of microplastics in fish

Microplastic particles in fish found at 3 stations ranged from 52 to 325 particles with a total of 90 fish samples. The diversity of microplastics can be caused by different levels of pollution in each water area. The forms of microplastics found in these waters are fragments, films, fibers and pellets. The abundance of microplastics at Station 1 (Ecotourism) can be seen in Table 2.

Table 1. Distributions of species found in all research stations.

Local Name	Species	Fish Caught
Kepala Batu	*Mallotus villosus*	10
Belanak	*Mugil seheli*	10
Lidah	*Cynoglossus lingua*	15
Tamban	*Spratelloides gracilis*	5
Senangin	*Eleutheronema tetradactylum*	10
Kerapu	*Epinephelus coioides*	10
Sembilang	*Paraplotosus albilabris*	10
Gulama	*Johnius trachycephalus*	5
Kembung	*Rastrelliger neglectus*	5
Selar	*Selaroides leptolepis*	5
Selanget	*Anodontostoma chacunda*	5
	TOTAL FISH	90

Table 2. Microplastic abundance at station 1, 2 and 3.

Stastion	Spesies	Microplastic Type (unit)				Total
		Film	Frag	Fiber	Pelet	
1	*Mallotus villosus*	9	42	86	13	150
	Mugil seheli	29	45	183	37	294
	Cynoglossus lingua	2	10	10	2	24
	Spratelloides gracilis	11	11	15	8	45
	Anodontostoma chacunda	13	39	31	13	96
	Total	*64*	*147*	*325*	*73*	*609*
2	*Eleutheronema tetradactylum*	65	66	75	47	253
	Epinephelus coioides	24	34	37	19	114
	Paraplotosus albilabris	50	73	68	29	220
	Total	*139*	*173*	*180*	*95*	*587*
3	*Johnius trachycephalus*	15	20	22	8	65
	Rastrelliger neglectus	22	26	26	12	86
	Selaroides leptolepis	15	19	25	10	69
	Cynoglossus lingua	26	40	48	22	136
	Total	*78*	*105*	*121*	*52*	*356*

Discussion

Microplastics will harm fish and other marine biota. The very small size of microplastics allows microplastics to be accidentally ingested by various marine organisms, one of which is fish (Yudhantariet al., 2019). According to research by Lusher *et al.* (2014) stated that of the 504 demersal and pelagic fish studied, as many as 5% found microplastics in their digestive tract. Demersal fish are types of fish that live in the wild at the bottom

or near the bottom of the waters (Ernawati, 2007). Whereas, Pelagic fish are fish that live in the environment water surface (Fréon et al., 2005 in Nelwan et al., 2015). Due to their very small size, microplastics in seawater can easily be internalized into the bodies of marine organisms (Nie *et al.*, 2019).

The research conducted by Sawalman *et al.* (2021). The research conducted by Budi which was carried out in the waters of Barranglompo Island, Makassar showed 931 microplastic particles. In this study, the results obtained at station 1 were the most dominant type of fiber with 325 particles from the results obtained, it is known that the mullet fish (Belanak) obtained a total of 294 particles with the most common type of fish found being Belanak. According to Ashuri *et al.* (2022). Mullet fish (Belanak) is an omnivore fish that is demersal, where this fish lives at the bottom of the water, resulting in a greater amount of microplastics contained in the fish being exposed to microplastics originating from sediment that is also consumed by the demersal fish.

Microplastics are commonly found in coastal areas and estuaries due to the influence of tides and wind (Jupriyati et al., 2013). Station 1 is a tourism area where many fishing activities are found at this station this is in line with research (Mohamed Nor and Obbard, 2014) which states that the form of fiber can come from synthetic fibers, rigging, and fishing nets. The abundance of microplastics in the waters at this station is the highest compared to other stations. Pozo *et al.* (2019) stated that fish that live in coastal waters close to human activities tend to be susceptible to exposure to microplastic fiber types.

At Station 1, it was found that mullet fish contained the most microplastics because mullet fish are demersal fish or can also be called benthopelagic fish, that is, it live and eats at the bottom of the water so that it can increase the possibility of digesting microplastics from sediment and water contaminated with microplastics (Prameswari et al., 2022; Whitfield, 2012).

At Station 2 the most common type found was Fiber with the type of Senangin fish which contained the most microplastics, namely 253 particles. These results indicate the similarity of the research conducted by Mirad *et al.* (2020) in Dumai Waters who found that the type of fiber was the most dominant in the digestive tract of Senangin fish. This is supported by the Directorate General of Fisheries in Titrawani *et al.* (2013) that Senangin fish are demersal fish in coastal areas and river estuaries and are classified as carnivore fish. The most dominant type of fiber microplastic found in fish is likely to come from synthetic materials in clothing and also fishing equipment such as fishing rods or nets, where station 2 is the route for fishermen looking for fish. This is in line with Johan *et al.* (2021) that this type of fiber mostly comes from fishing lines or fishermen's fishing nets. These results show that there is a compatibility with research conducted by Mirad *et al.* (2020) with the dominant type of microplastic, namely fiber in Senangin fish. The main factor that supports microplastics entering the digestive tract is thought to be the wrong identification of prey, this is microplastic similar to plankton which is the natural food of fish (Setälä et al., 2014)

The result of Station 3, the most dominant type of fiber was obtained and Lidah fish contained the most microplastics with the dominant type of fiber. Fiber-type microplastics were found at this station because this station is a fishing waters zone where fishermen carry out a lot of fishing activities at this station. This shows similarities with the research of Yona *et al.* (2020), the microplastics found in the digestive tract of fish are a type of fiber that is thought to come from fishing activities such as fishing lines and also nets discarded in the water. In the study of Sulistiono *et al.* (2011) which states that the Lidah fish is a type of carnivore fish that lives at the bottom of the waters with the main food being mainly shrimp. Microplastics can be ingested by fish intentionally or unintentionally during their search for food because their shape is almost the same as the type of food or because their prey has been contaminated with microplastics (Neves *et al.*, 2015).

Microplastics in the marine environment can harm marine life including pelagic fish such as Selar and Kembung. Kembung fish live in groups and enter estuary waters to find food in the form of plankton, copepods and crustaceans (Putra *et al.*, 2019). Selar fish is a carnivorous fish and carnivorous fish usually do not take long to digest their food (Sriyanti et al., 2017). The results of this study are the same as those conducted by Senduk et al. (2021) at TPI Semarang and Kendal who obtained more microplastic values in mackerel than selar fish. According to Jabeen *et al.* (2017), the consumption and abundance of microplastics can be influenced by eating habits and habitat conditions and high fiber consumption from the food consumed by these fish in nature will take a long time to digest.

Based on the three research stations, it was found that the least type of pellet was found and the other 3 types were dominant. Because these 3 types of

microplastics are secondary sources of microplastics, this is supported by Mirad *et al.* (2020) which states that secondary microplastic sources include fibers or pieces resulting from chain breaking of larger plastics that may occur and secondary microplastic sources have a relatively longer residence time in water areas.

In the results of research conducted by Rummel *et al.* (2016), the dominant type of microplastic found in pelagic and demersal fish is fiber. According to Sandra and Radityaningrum (2021) that microplastics that accumulate in aquatic biota, both herbivorous, carnivorous and omnivorous types have different abundances. This is due to the level of pollution in the waters, the behavior of biota and different habitats.

Conclusion

The average abundance of microplastics in fish samples ranged from 24– 194 particles/individual and the types of microplastics found were Fiber, Fragments, Films and Pellets with the most dominant types of Fiber found

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